## MECHANICAL SYSTEMS

### WHEN TO CONSIDER

| | | | |
|---|---|---|---|
| NEEDS ASSESSMENT | NO | SCHEMATIC DESIGN | YES |
| MASTER PLANNING | NO | DESIGN DEVELOPMENT | YES |
| PROJECT STATEMENT | MAYBE | CONSTRUCTION DOCUMENTS | DONE |
| ARCHITECTURAL PROGRAMMING | YES | CONSTRUCTION | DONE |

NO-Need not consider.
MAYBE-This system may be considered.
YES-This system should be considered.
DONE-This system should have already been considered.

### DESCRIPTION

The building's mechanical system provides the environmental control, including heating, cooling, fresh air supply and humidity. This system typically costs 10 to 15 percent of the cost of the building, depending on the climate, design of the building envelope, and the type of systems selected to provide the desired environmental conditions in the building.

**The most important thing you can do to get the mechanical you need, want and can afford is communicate these goals to your designer.** The designer needs to know:

- How you wilt use each space and how many people will be located there.

- Your environmental needs for each space. Do you want to heat the space only or heat and cool the space? If the space is cooled, what temperature do you want to maintain? Just because a space will be cooled doesn't mean the space must be cooled to what most people think of as air-conditioned.

- Your budget for the mechanical system: As discussed in the introduction of Section III, the design-to-cost model breakout of the project should allocate dollar resources to each building system so the design can be developed according to a budget amount for each system. When designers are unaware of budget parameters, they will strive to "give" the client the "best" system possible. As with most things, the "best" system is the most expensive solution. Therefore, it is essential the architect, as coordinator of all the consultants, communicates the budget parameters for the mechanical system.

- The amount of control you wish to maintain from space to space in the building. Controlling the environment in each room differs in price substantially from controlling a number of adjacent spaces together.

- The type of equipment and lighting fixtures you want in each space. Because equipment and lighting emit heat, the cooling portion of the system must be able to accommodate these loads. This heat gain will offset the heating needs of a space.

Because your architect is responsible for the overall coordination of the systems within the building, the mechanical consultant will be working for the architect. It is the architects job to make sure all of this information is collected and communicated to the mechanical consultant. If these questions are not being asked, the mechanical designer may be basing the design on assumptions from previous similar projects. Generally, such assumptions lead to an over-designed system.

Life-cycle cost is important when selecting your mechanical system. The energy cost to run the system, the equipment replacement time, and the amount of control should be compared to the first-cost. In general, the more expensive first-cost systems typically provide more control and have greater longevity than low first-cost systems. Analyze your options. As with any life-cycle analysis, the figures are derived from many subjective assumptions. Scrutinize these assumptions more so than the bottom line cost to make a prudent decision, whether the pay-back on a more expensive system is worth the first-cost and if you have enough first-cost dollars to pay for the "best" system.

When your design team is presenting options on first-cost versus life-cycle cost, be aware that a complicated "energy efficient" design will only be energy efficient and provide a better environment if properly maintained. Therefore, a simpler, less expensive and perhaps less comfortable system (in terms of controls) may, in fact, prove to be a more economical choice In life-cycle terms because it will be easier to maintain. To avoid buying a complicated mechanical system which looks good on paper, involve a staff maintenance person when you make your selection. If that person doesn't understand how it works and what it will take to maintain it, the "best" choice may be wasted.

## RELATIONSHIP TO OTHER SYSTEMS

The mechanical system must fit among the other building components, such as roofs, ceilings, columns and beams, piping and ductwork. The equipment must be accommodated inside the building, on the roof or on the ground. The electrical system will affect sizing of heating and cooling loads because of the heat it generates. In a secure environment, inmate access to the system's components becomes an important consideration

## ALTERNATIVES

Because of the volume of information required to describe all of the systems available (the most common are listed in the matrix), a discussion of each in this Handbook is not practical.  The matrix should be used as a general reference.  Discussion of some general differences follows.

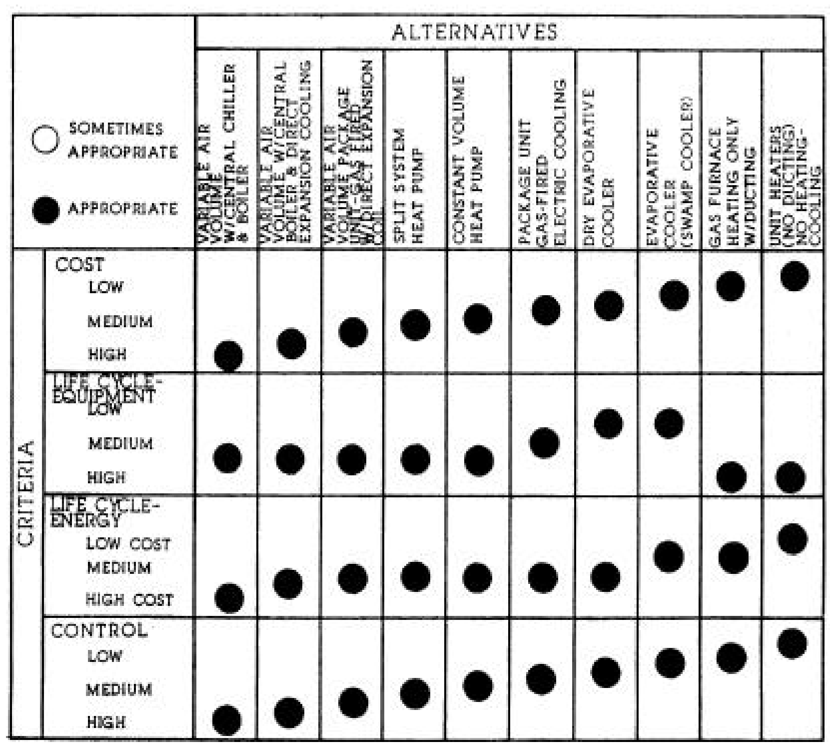
### Centralized Systems Versus Decentralized Systems

A centralized system uses heating or heating and cooling devices located throughout the facility, piping or ducting a heated or cooled medium (steam, hot water or air) to various locations throughout the system.  This system can service one or a number of buildings.  You have greater control with a central plant; its primary equipment is designed for long-term use.  First costs and energy costs usually are higher.

Decentralized systems use a number of heating or heating and cooling devices located throughout the facility.  The energy source, typically gas, for heating and electricity for the cooling are delivered directly to the units.  First-costs are usually lower and energy costs also may be.  Control, however, is not as good, and some of the equipment is not designed for longterm use.

Gas-fired unit heaters (typically found in industrial and warehouse/maintenance facilities) are found at the low end of the cost scale.  Central heating and cooling plants define the high end.  It is very common to use a variety of equipment for one facility to serve different purposes.  For instance, you can use unit heaters in the storage and maintenance areas, evaporative coolers in the housing areas, and a variable air volume system for the administrative areas.  The cost per square foot for these alternatives will range from under $14 per square foot to $25 per square foot.  Mechanical needs for each space should be considered separately.

### Mechanical Systems Matrix



## ELECTRICAL SYSTEMS

### WHEN TO CONSIDER

| | | | |
|---|---|---|---|
| NEEDS ASSESSMENT | NO | SCHEMATIC DESIGN | YES |
| MASTER PLANNING | NO | DESIGN DEVELOPMENT | YES |
| PROJECT STATEMENT | MAYBE | CONSTRUCTION DOCUMENTS | DONE |
| ARCHITECTURAL PROGRAMMING | YES | CONSTRUCTION | DONE |

NO-Need not consider.
MAYBE-This system may be considered.
YES-This system should be considered.
DONE-This system should have already been considered.

### DESCRIPTION

Your facility's electrical system will have the following components:

- Site distribution.
- Site lighting.
- Major electrical equipment such as switchgear, transformers and emergency generators (may be located outside the building).
- Building distribution elements including raceways, wire, circuit panels and smaller transformers.
- Lighting, outlet and switch devices.

Similar to a mechanical system, the best way to get a functional, cost-effective electrical design is to establish user needs and budget parameters before the design work begins. If you lack the technical expertise, you must rely on your architect to ask the right questions about user needs and on your architect and cost analyst to determine budget parameters.

Establishing user needs (lighting levels and power requirements for equipment) before beginning design is important because when designers are left with uncertainties, they tend to over design lighting and power systems. If the footcandle levels (the measurement of light in a space) are specified 20 percent higher than need be and every light and outlet is assumed to be used at all times, the design of the entire system will cost more due to larger service, switchgear and emergency equipment. (The calculation of amount of power is determined by a "diversity factor," that is how much of the electrical load will be used at once.)

When hiring your architect, find out who the electrical consultant will be. Question the firm's design methodology and clarify that you expect the system to be designed avoiding the "rule of thumb" conservative and "safe" approach to design. The designer should use computerized programs for calculating necessary lighting levels and power loads.

## RELATIONSHIP TO OTHER SYSTEMS

The electrical system must respond to the other systems it services. The finishes, ceiling heights and number of windows play a large part in how the lighting works. Providing power to the mechanical, kitchen, laundry and other equipment determines power load and switchgear needs. Once again, the architect must make sure all of the systems work together,

## ALTERNATIVES

Electrical systems are composed of too many components to be displayed in a matrix. However, a number of cost-related concepts are briefly discussed below.

### Site Distribution And Lighting

Depending on the size and complexity of your facility (one building or numerous buildings), the amount of electrical distribution may range from simple service to the building and parking lot lighting to a complex distribution system between different buildings on the site. If you have a great deal of site distribution, consider overhead wiring as It can be less expensive than underground distribution if economically designed. Security and appearance aspects also must be considered in this decision. The least expensive underground distribution uses PVC conduits for raceways. A more expensive solution is rigid steel conduit. Still more expensive (roughly 10 times the expense of PVC) is the option of encasing them in concrete.

High voltage distribution generally is less expensive than low voltage because the size of cable increases dramatically for long runs of low voltage cable.

Wood poles for overhead power or lighting are the least expensive. "Roadway design" poles and fixtures are the next most economical; "architectural" are the most expensive. Roadway design are standard economical fixtures used for roadways. Architectural design uses more customized poles and fixtures with more expensive finishes and shapes.

## Building Distribution And Power

PVC conduit under slabs is more economical than rigid steel conduit.

Aluminum feeders are less expensive than copper feeders but must be installed properly at connection points. Inspection of connectors is critical. Aluminum buss panels are less expensive than those made of copper. Drawout breakers cost approximately twice that of molded case breakers. (Drawout breakers can be removed without de-energizing the panel.)

Listing a number of manufacturers for any specified product improves competitive material prices.

Use of stub-in breakers is less expensive than bolt-on breakers.

The diversity factor used to size power loads dramatically affects sizing of equipment. A factor of 1 assumes all outlets and power loads will be used simultaneously. This results in the most conservative design.

Electric Metallic Tubing (EMT) conduit (also known as thin-wall conduit) costs a fraction of rigid steel conduit.

## Light Fixtures

Selecting fixtures should be conducted room-by-room because security fixtures can cost many times more than standard fixtures. Zone where security fixtures are needed. Heavy duty, off-the-shelf industrial or commercial fixtures often will suffice where security is an issue. Consider access to the fixture. If it is inaccessible, a security fixture may not be necessary.

Specify as many competitive brand names as possible to increase competition.